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Lack of effectiveness in current instructional output is due to the nature of the theories formulated to improve the structuring of the content of instruction. A rationale is presented for a theoretical position. Based upon this rationale a paradigm is outlined which provides the basis for a comprehensive category system for instructional design data and related strategies. Points are made concerning the important implications of such a rationale and paradigm for the development of a technologically useful network of curricular and instructional theory. Such technological design paradigms provide a basis for internally consistent, functionally related, and mutually supporting category systems for the ordering of instructional design data and decisions. The paradigms provide a basis for developing specific design strategies and techniques and provide a reasonable approach to defining concepts such as curriculum and instruction. A 46-item bibliography is included. (MLF)

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A Technological Rationale for Curriculum and Instruction[1]

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Introduction

From all sides we have been warned that the instructional enterprise is failing to meet its obligations to society. While few within the enterprise would question the face validity of this statement, the enterprise itself seems to be unsure as to the sources of this ineffectiveness and of the prerequisite nature of the corrective measures to be taken.

In general, the enterprise appears to have been concerned with research activity in three related research areas: i. e., in: (1) philosophical, psychological, and disciplinary issues related to the content of instruction; (2) management and administrative issues related to the development, innovation, and evaluation of instruction; and (3) instructional design issues related to the structuring of the content of instruction for given sets of goals, learners, and environmental contingencies. Historically, it seems, the literature of the field has focused primarily on the first two of these domains. It is only during the last decade that any

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serious attention has been given to the problems of instructional design per se. It is this third, relatively untouched, and primitive area of investigation which I view as being of prerequisite importance to improving the output of the instructional enterprise.

The problem of deriving a more powerful theoretical basis for instructional design is a difficult one. As a number of authors have pointed out (see especially Elliott and Foshay 1963) instructional decision making has always been suspect, first because it was not based on theory, and secondly because it was. The early efforts at social science theory building in instruction have been notably unsuccessful. Those who advocate theoretically based instructional design have been hard pressed to generate the required theoretical formulations. Such formulations have drawn criticism on the basis that: (1) They are not scientific at all, but normative, and prescriptive—based upon common wisdom rather than upon empirical science. (2) They are inappropriate to the control of "value-directed" human behavior. And (3), most important, they have failed to produce the sort of pragmatic pay-off associated with technologies, such as medicine and engineering.

Against this general background this paper focuses on three issues which I believe to be of theoretical importance for improving the pragmatic pay-off of instructional theorizing. First, it is argued that the lack of efficacy in current instructional output is due, not to any decision to employ theoretical as opposed to empirical based research, but to the nature of the theoretical formulations which have been given prerequisite attention. Secondly, a rationale is presented for what I believe to be a much more

powerful theoretical position than many of those traditionally employed by the instructional enterprise. Based upon this rationale, a paradigm is then outlined which, it is suggested, provides the basis for a comprehensive category system for instructional design data and related strategies. In conclusion, several points are made concerning the important implications of such a rationale and paradigm for the development of a technologically useful network of curricular and instructional theory.

The Prerequisite Nature of Instructional Theorizing

A review of current literature in curriculum and instruction leaves the reader with little doubt of its ultimate goal, i. e., the development of a "scientific theory of instruction." The literature abounds with speculations as to the nature of such a theory, and of its relationship to theories of teaching, learning, and/or curriculum (Johnson 1967; Maccia, Maccia, and Jewitt 1963; Macdonald and Leeper 1965; Macdonald 1967; Siegel 1967; and Travers 1966, 1967.) The development of scientific theories, such as those described by Beauchamp (1968) and Gordon (1968), for use in explaining and/or understanding of curricular and instructional phenomena appears to be a crucial step in improving the rigor of the instructional process. Yet the question must be asked as to whether such theories are of a prerequisite nature, either in terms of the obligations of the instructional enterprise to society, or in terms of the theoretical process by which such theories of instruction are likely to evolve.

It seems evident that the primary goal and obligation of the instructional enterprise is the controlling and effecting of specific

changes in instructional environments. To this extent, it would appear that the prerequisite functions to be performed by the enterprise ought to be directed towards developing powerful design specifications and related techniques, and not to the ultimate understanding of the phenomena with which it works. Clearly then, it is a technological theory of instruction and not a scientific one which is the prerequisite responsibility of the enterprise. [1]

This position does not deny the crucial importance of sophisticated scientific understandings to technological innovations. It emphasizes, instead, that: (1)Technological theorizing is methodologically different to scientific theorizing. (2) Scientific understandings are a part of relatively sophisticated fields of study, of which the "science of instruction" is surely not one. (3) Relative technological sophistication in a given field is not dependent upon equivalent levels of scientific sophistication in its related subject matter areas. (4) Substantively related sciences and technologies develop in a parallel rather than in a sequential manner, the two being mutually supporting and interacting in their conceptual contributions to each other. [2] And (5) while the sciences

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[1] The inherently technological nature of instruction has been argued in more philosophical terms by Hirst (1963) who points out that instruction is primarily concerned with "intentional activities" and "practical judgements" based upon a complex network of understandings which cannot be reduced to any simple scientific deductive system. Jackson (1968, pp. 173-174) makes a similar point in his emphasis on instructional questions relating to the "how" rather than to the "why" of human behavior.

[2] This distinction between sciences and technologies concerns their different content, goals, related modes of functioning, and evaluative criteria. A number of writers have called attention to these distinctions and/or have noted their implications for instruction (see especially: Finan 1963; Melton 1959, 1960; Miller 1963, 1965; Polanyi 1958; Wigglesworth 1955; Wolman 1965.) The fact that technology is by general definition also a science need not confound

provide a climate for thought as well as many of the valuable conceptual tools employed by the technologist, the technologist's methodology is not that of the scientist. The technologist is not limited to the inductive and deductive processes of theoretical science, but bases his methodology instead upon "soundly cultivated judgements" (Wigglesworth 1955). As Wigglesworth (1955, p. 41) has pointed out: "To advise him to think scientifically would risk paralysing his judgement rather than activating it." In short, technology is intrinsically a "black box" probabilistic activity, dependent only upon knowledge of inputs and required output topographies. While the technologist welcomes scientific information concerning intervening phenomena and processes, his methodology is by no means dependent upon such data.

Clearly, the position taken here on the prerequisite technological nature of instruction implies a good deal more than the use of "technology in instruction". During the last half century many criticisms have been directed against the use of technological concepts by the instructional enterprise. While many of these appear to be well founded, they often fail to make clear the important distinctions between the use of technology as a basis for: (1) aims statement for instruction, or (2) criteria for instruction, or (3) possible decision strategies for instruction, or (4) instrumentsin an instructional system; and the notion of technology as a principle of methodological decision. In the first instance, the focus is

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the point being made here, i. e., technology is "the science of the application of knowledge to practical purposes" (Webster's New Third International Dictionary.)

on an "instruction for life syndrome"; in the second, on an "efficiency and effectiveness syndrome"; in the third on a "feedback", as opposed to an aesthetic or intuitive syndrome; and in the fourth instance, on the use of "engineering technology" or a hardware syndrome in instruction.

Again, sound bases seem to exist for the criticism of these sorts of syndromes, as they have been described by Callahan (1962), Jackson (1968, pp. 159 - 171), Macdonald (1967), McLuchan (1963), and many others. However, such criticisms appear to be based on a recognition of only the more obvious procedural attributes of technology, rather than upon its more basic modes of functioning. It seems unlikely that those who have been so outspoken concerning the use of technology in such contexts would suggest that instruction is indeed not praxiological in its goals and thus should not give attention to the investigation of basic technological modes of functioning.

There is, of course, certainly nothing new about the notion that the field of instruction is praxiological in its outlook, being concerned with identifying what "ought to be done" describing the necessary strategies for "doing it", and with "evaluating the results". In spite of this, however, the literature of the field continues to be primarily concerned with the scientific studies of the psychologist or sociologist. When technological issues are dealt with in the literature, they are generally on a technologically unsophisticated, anecdotal, and prescriptive basis. Given the technological nature of instructional goals, it seems evident that more attention ought to be given to developing more sophisticated technological descriptions of the instructional process.

In order to demonstrate the crucial difference in the theoretical

focus provided by these two decision systems in the field of instruction, let us stop and review briefly the essential differences in their content, goals, functions, and evaluative criteria: (1) While science focuses on investigating the behavior of components in abstract and surogate environments, in order to reduce variability and confoundedness, technology investigates the behavior of components in real world septic environments in order to maximize this variability and counfoundedness. (2) While the goals of science are the control and/or the explanation and understanding of phenomena, those of technology are focused on optimizing the control of environments. As Fogel (1963, p. 4) points out, the scientist "does to know" while the technologist "knows to do." (3) While the scientist processes data in a manner calculated to lead him from a set of causal conditions to a related set of effects, the technologist reverses this order and works backwards. Starting with a desired effect, the technologist attempts to identify the required set of independent causal conditions. While the scientific processes by which this former activity is carried on is referred to as "discovery", the latter is generally referred to as "invention". In the first instance the processes of induction, deduction, and hypothetico-deduction are commonly employed. In the latter instance such logic and rationality give way to stochastic decision structures for relating means and ends. Such structures are developed by analogical and metaphorical extension and by criterion trade-offs based on intuition, and common wisdom, as well as on empirical science. (4) While scientific theorizing depends for its power primarily upon empirical sensory data inputs, technological theorizing depends primarily upon the "hunches" of the technologist. (5) While the outputs of the scientist are

inductive and deductive explanatory statements, those of the technologist are forecasts which attempt "to indicate in advance the extent to which a state of affairs can be anticipated by means of some set of independently selected variables" (Finan 1963, p. 530). (6) Finally, while scientific theories are evaluated in terms of their relative power for relating facts within a theoretical network, technological theories are evaluated in terms of the probability of their forecasts. In the first instance the criteria are those of reliability and validity in "explanation" and "prediction." In the second instance the criteria are those of reliability and fidelity in "interpretation" and "forecasting".

What then might be the result if the instructional enterprise were to give prerequisite attention to the development of a more sophisticated technological methodology rather than to scientific theorizing? I would like to suggest that the following innovations might logically be expected: (1) a renewed emphasis on the study of task, learner, and instrumental variables associated with the acquisition of meaningful human capabilities rather than on the learning of capabilities by surogate infrahuman species; (2) a primary emphasis on the study of the "how" of instruction rather than on the "why" of human behavior; (3) a primary emphasis on the invention of powerful instructional strategies rather than on the discovery of logical inductive or deductive systems of explanation; (4) a primary emphasis on the compilation of handbooks and design specifications containing artful, heuristic, and highly empirical, as well as scientific design data rather than upon the development and validating of scientific theories of instruction, and (5) a primary emphasis on the design of

strategies for testing the forecasting and interpretive power of specific instructional techniques rather than for testing the reliability and the validity of principles and theories of instruction.

It seems certain that the Romans built fine bridges and roads, not because of their scientific sophistication in explanation and prediction, but because of their technological sophistication in interpretation and forecasting. Their inductive and deductive explanatory theories were primitive indeed, judged by our present level of scientific knowhow. Yet, on the other hand, their technological output, in bridge and road building, was equivalent in many ways to our own. The difference, I suggest, is due to the prerequisite attention which the Romans gave to technological theorizing.

It would be naive, of course, to suggest that man can ever descriptively control[1] human behavior in the same manner as he can now control the behavior of many inanimate systems. The situations, however, appear, to vary in degree rather than in kind. Both activities are intrinsically technological in nature, requiring the application of similar methodologies.

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[1] The concept of control of human behavior, like that of "technology in instruction" has been the source of a good deal of philosophical, moral, and ethical debate. While much of this discussion seems to be entirely necessary and useful it is again not directly related to the point being made here. Technological control is descriptive and symbolic in nature. In the case of instruction, it involves the preparation of specifications for inducing rule governing behavior, i. e., rational behavior from irrational behavior, self-control from external instructional control. The problem of identifying specific instances in which such control specifications are to be employed is a different but equally important problem.

They differ mainly in their levels of technological sophistication, i. e., in the ratio of hard scientific data to their heuristic and artful design inputs.

From this brief discussion of the nature of technology and its relation to instruction, I suggest first, that instruction is indeed a technology, in its goals and therefore in its related modes of functioning. Secondly, that the efficacy of technology, as a principle of methodological decision, has been clearly demonstrated, historically in the design of machine systems, and more recently in the design of man-machine systems.[1] The potential power of such a methodology for the field of instruction therefore seems evident. Finally, and most important, I should like to suggest that the prerequisite task in instructional theory building ought to be the development of conceptual structures for identifying and ordering the criteria, parameters, and techniques required for the design of instructional systems.

On the basis of this argument, the next research question which might be asked is: "What is the range and nature of the criteria, parameters, and techniques required for the design of powerful instructional systems?" It is to this question which I should now like to turn.

The Range and Nature of Technological Decision Making

Technological design methodology currently takes account of a much broader range of real world phenomena than has traditionally been the case. In all technological fields the increased complexity and the costs of systen

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[1] See Gagné (1963) for an outline of such research findings.

development and operation have forced designers to employ increasingly sophisticated design strategies in order to improve the ultimate forecasting power of their specifications. No longer is the designer's task limited to that of identifying criteria, parameters, and techniques for component selection and performance alone. He must now accept the responsibility for the descriptive control of broad range of production management, and administrative decisions not at all evident in less sophisticated technological eras.

Current technological design practice appears to recognize a number of discrete domains of design decision making, each with its own related sets of specifications. While each set of specifications provides descriptive control of a discrete category of design parameters, criteria, and related variables, no set of specification is in itself complete without inputs and feedback from the other related sets. Collectively, these specifications appear to constitute a symbolic system of interacting and mutually supporting specifications for the descriptive control of a specific empirical system.[1]

More specifically, four categories of design specifications may be identified as being representative of those which are intended to cover this new range of design responsibility, i. e., a"predesign"specification,

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[1] The terms "empirical" and "symbolic" are employed here in the manner in which they are used by Easton (1965, p. 26). The author uses the term empirical system to refer to a complex of mutually supporting and interacting "objects of observation", as parts of "phenomenal reality". The term symbolic system, on the other hand, describes a parallel complex of symbols intended for the descriptive control, explanation, and/or understanding of such an empirical system.

a "design" specification, an "operational" specification, and an "operations" specification.[1]

The function of the predesign specification appears to be to identify and order the various goals and related inputs, outputs, mediating processes, and environmental contingencies related to the performance of the completed empirical system. The predesign specification provides, in effect, a functional description of a completed system. Based upon this system description and subsequent systems analyses, the design specification then identifies the components and the performance criteria and parameters required for the operation of such a system. The design specification constitutes, in effect, a set of product and performance specifications for the completed system. Premised on this set of specifications, an operational statement is then prepared. Its function is the descriptive management (i. e., monitoring, regulating, and controlling) of the components selected in the design specification, in order that these performance objectives may be met. The operational specification then constitutes, in its effect, a production management specification. It extends the static design specification into a dynamic, spatially, and temporally structured work setting. Finally, an operations specification is prepared as a basis for making quantitative administrative type decisions about the performance

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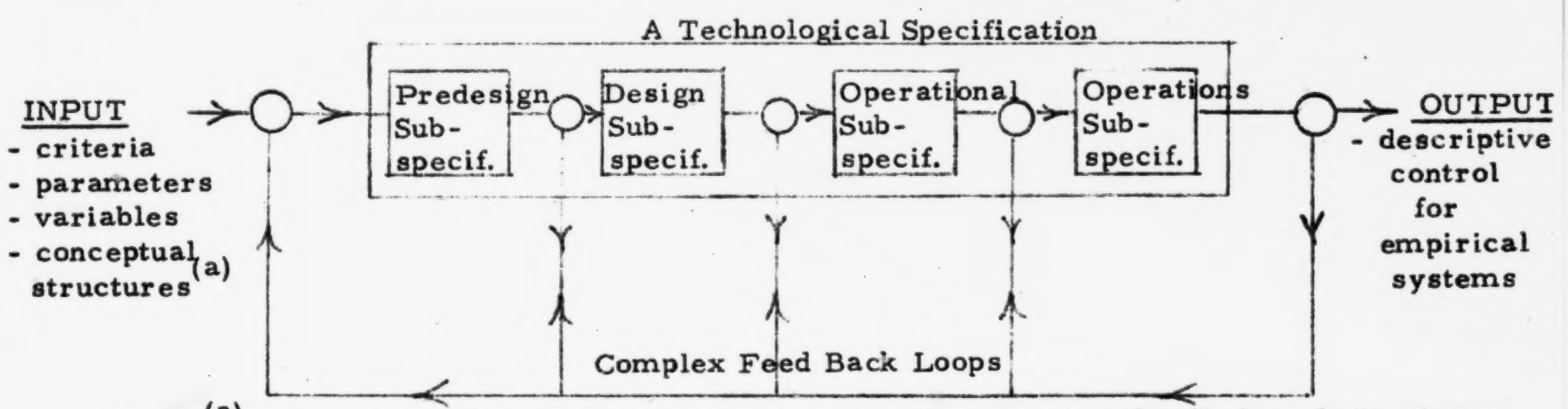
[1] This does not suggest that there is, as yet, any general agreement amongst system designers as to the number or nature of these domains. Those identified here are considered to be representative only. For a discussion of various aspects of the technological design process see especially Krick (1966), Howland (1966), Meister and Rabideau (1965), Connelly (1961).

of the final product or process within a given environmental context. The operations specification is, in effect, a grand strategy for helping executive decision makers to control the operations of the systems and components for which they are responsible.

In short, the predesign specification appears to provide descriptive control of system functioning, the design specification provides descriptive control of system performance, the operational specification provides descriptive control of system production management and the operations specification provides descriptive control of system administration in a specific contexts. Figure 1 illustrates schematically such a symbolic system for the descriptive control of a wide range of empirical systems. Figure 1 constitutes a highly generalized paradigm for the design of technological processes or products.

Figure 1. -- A Generalized Technological Design Paradigm for the Descriptive Control of Empirical Systems.



Note: (a) These may include a wide range of intuitively and scientifically based structures upon which the technologist makes design decisions—paradigms, models, rationales, and theories. See Gordon (1968) for a discussion of the necessary criteria for scientific theories of instruction.

Generalized conceptual structures such as the one outlined in Figure 1 appear to provide the technological designer with a good deal of assistance in helping him to conceptualize the total design context in which he operates. At the same time, however, the designer must continually remind himself of the limitations of such simplistic conceptual structures. While such paradigms carry with them great heuristic potential, they are at the best tentative statements about presumed relationships and therefore must not be thought of as descriptions of reality. Thus, Figure 1 is not intended to suggest that technological decision making can ever be reduced to a completely rational and reasonable process.

A second caution should also be recognized with respect to the application of such deceptively simplistic design paradigms. The simple schematic nature of Figure 1 should not be taken to suggest that each of its four related subspecifications are in themselves simple statements of fact, requiring the application of only relatively simple static, linear, and unidimensional analytical processes for their identification. Rather, the technological design process suggested here is one which is dynamic, stochastic, and multidimensional. It consists of many interrelated and mutually supporting design decisions on almost an infinite number of analytical levels. Indeed, the number and sophistication of the analytical techniques employed by the designer appear to be limited only by his own inventiveness and by their potential for pragmatic pay-off.

Let us now examine such a technological design paradigm for its potential meaning and significance in the field of instruction.

A Technological Paradigm for the Design of Instruction

While the literature is by no means clear on the matter, there does appear to be some agreement on the fact that, whatever else it may be, formal instruction is at least an empirical system involving a complex of real world objects such as learners, and curricula, and even teachers and machines. It also seems evident that whatever else curricula may be, they are at least symbolic systems or specifications intended to provide some form of descriptive control for instruction. As Macdonald and Leeper (1965, p. 5) have implied curricula and instruction are two different action systems—while curricula are plans for action, instruction is concerned with putting such plans into action.

The use of a technological design paradigm as a perceptual screen for identifying and ordering curricular and instructional phenomena appears to have much to recommend it. Not only does it circumscribe the total range of phenomena to be brought under the control by the designer of instructional systems, but it also identifies within this category a number of subcategories of design criteria and parameter which appear to be both meaningful and significant.

In an instructional system context the function of the predesign specification is to identify and describe the purposes, goals and related functions of instruction within a given society. The task of the design specification is to be to identify the performance objectives for specific learners or groups of learners within that society, and to identify and structure the required learning tasks. Making use of these

performance objectives and learning tasks, the function of the operational specification is then to identify how these objectives can be met in terms of the management of types of system components (i. e., learners, curricula, teachers, and/or machines). Finally, the function of the operations specification is to identify the range of parameters and criteria to be dealt with by teachers faced with executive decisions as to the selection and operation of various instructional system components.

In short, the predesign specification provides descriptive control of the dependent events (i. e., learner capabilities) to be invented by the instructional technologist. The design, operational, and operations specifications then provide descriptive control of the related independent events of instruction, i. e., the required learning tasks, their production management and their administration respectively.

Figure 2 summarizes these four subspecifications which a comprehensive specification for instruction might be expected to include. Figure 2 provides, in effect, a technological analysis of the domain of events which should be controlled by the designer of instructional systems. I suggest, that in addition, Figure 2 also provides a reasonable first approximation to a useful real or analytical definition[1] of curricula; and the Figure 1 similarly provides a schematic view of a curriculum as a comprehensive specification for instruction?

It is important to note at this point that the control provided by such specifications is primarily "desciptive" rather than "prescriptive" in nature. Teachers, like engineers and doctors, are called upon to make many executive type decisions which involve philosophical, moral, ethical

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[1] Cohen and Nagel (1934, pp. 230, 231) describe "real definitions" as those in which the right side means precisely what the left does, but in addition, the right side provides an analysis of the symbolic structure to which they both refer.

Figure 2. -- The Function of Four Subspecifications in the Descriptive Control of Instructional Systems.

Subspecification	Function	Typical Design Questions[a]
Predesign	Provides descriptive control of the purposes, goals and related functions of instruction in given social environments - the dependent events of instruction.	What societal demands must be met by the instructional enterprise?
Design	Provides descriptive control of learning task content, structure, and proficiency levels for given learners in society - independent events of instruction.	What learner capabilities are required to meet these demands? What are their contents, structures, and levels of proficiency?
Operational	Provides descriptive control of the production management of the required learning tasks, i. e., the interactions between specific types of learners, teachers, and/or machines in a given operating context - independent events of instruction.	What instructional strategies and tactics are required to ensure the acquisition of these capabilities by given types of learners?
Operations	Provides descriptive control of the administrative decisions required for the operation of the instructional system and its components - independent event of instruction.	Which design and operational specifications ought to be employed for this learner in this particular situation?

Notes: [a] The design questions suggested at each level are typical of a number of questions to which the instructional system designer seeks answers. A number of analytical levels, at which significant design questions may be asked, may be identified within each of these four categories.

and historical questions which are a matter of personal concern and responsibility for them. While the sorts of specifications being described here are of infinite value in making these decisions, they are by no means prescriptive in that function. Their focus is rather one of: "Given these goals and operating conditions, we have found that doing it this way provides a reasonable probability of success."

The engineering technologist, faced with a design specification which seems to run counter to his general experience and to his first hand knowledge of certain operational situations, does not hesitate to make the appropriate alterations. This process is part of his professional obligation, and constitutes a crucial theoretical link in the feedback process outlined in Figure 1. A similar notion of the role of the classroom teacher in the technical and executive decision making process might add a good deal to current discussions of the role of the teacher in curriculum design and development.

Substantively it might seem that little new has been added by the use of such a technological paradigm. Certainly a long history of concern is evident for the sorts of content dealt with by the predesign specification. In more recent times Tyler (1950) and the "evaluation movement" have been instrumental in giving this domain new meaning and focus. Similarly, the content of the design specification has been the focus of much research by the evaluation movement (Bloom 1956, Mager 1962, Lindvall 1964), the programmed instruction movement (Glaser 1965b), and the military training movement (Glaser 1965a, Gagné 1963). The content of the

operational specification has long been the focus of attention of the media and communications expert, as has operations decision making long been the concern of writers in the field of curriculum development (Klohr 1967).

However, on the other hand, the use of such a paradigm appears to carry with it a number of important structural and methodological implications. By identifying and ordering instructional design data into a series of technologically meaningful, and mutually supporting and interacting categories, the paradigm might well provide as powerful a basis for instructional system design, as it has for the design of other empirical systems.

In summary, the argument has been that technological design paradigms, such as the one outlined above, are powerful conceptual tools for identifying and ordering the vast range of design decisions which must be made by the instructional system designer. Such paradigms provide a basis for internally consistent, functionally related, and mutually supporting category systems for the ordering of instructional design data and decisions. They also provide a powerful basis for developing specific design strategies and techniques. They may even provide a reasonable approach to defining such useful constructs as curriculum and instruction.

Some Implications for the Instructional Enterprise

I should now like to draw attention to some important theoretical implications which I see in the adoption of such a technological systems approach to instruction. Specifically, attention is drawn to: (1) some general paradigmatic implications related to the power of the

conceptual structure outlined here; (2) some taxonomic implications related to the use of the paradigm for generating category systems for the identifying and ordering of the "conditions of instruction"; (3) some defining implications concerning the potential of the paradigm for improved communication within the enterprise; (4) some monographic implications for the development of technological design handbooks; and (5) finally, some professional and institutional implications related to organizational and administrative issues in the field of instruction.

1. It has now become quite clear that the search for a comprehensive theory of instruction has not been a profitable one. While the enterprise desperately needs some kind of macro structure for identifying and for integrating instructional decision making, such a structure is not likely to be of the scientific inductive or deductive type. As Hirst (1963, p. 54) points out: "We need to think in terms of a much looser and much more open process of judgement to which philosophical beliefs, psychological and social theory, etc. contribute in their appropriate ways."

The instructional technologist, like the engineering technologist, is finding that paradigms premised on naive assumptions concerning the linearity, static, and independent nature of real world systems are not inducive to powerful technological theorizing. However, what has proved immensely powerful in the field of engineering, are paradigms which recognize the stochastic, dynamic, and mutually supporting and interacting nature of real world events. While such complex networks of understandings are difficult to express in a formal and rational manner, they appear to provide the only basis for predicting the relative success or failure of

technological outcomes.

Although the paradigm suggested here is highly abstract and generalized in terms of the number of hierarchical levels of decision making which it subsumes, it nonetheless does recognize the non-linearity, dynamic, and mutually supporting and interacting nature of instructional design decisions. Such paradigms have contributed immeasurably to forecasting the operational success of other types of processes and products. Their application in the field of instruction would therefore seem to have potential for the integration of the traditionally isolated realms of instructional decision making previously noted (above, p. 1), and for superseding many of the simplistic, fragmented, and internally inconsistent theoretical structures now being employed in the field.

The current trend towards the use of instructional packages and idiosyncratic instruction provides an excellent example of the need for such a technologically powerful approach. It seems likely that the demand for increasingly sophisticated instructional packages will parallel closely the demand for idiosyncratic instruction. The forecasting power of such packages is the responsibility of, and a matter of great concern for the teacher, as are operations decisions related to their use and evaluation.

2. Closely related to point one above is the potential of such a paradigm for generating a system of meaningful and significant categories for instructional design data, i. e., for the conditions of instruction.

The literature abounds with category systems which attempt to order task, learner, and instrumental parameters and criteria along various dimensions. While many such systems may make useful distinctions for scientific classification purposes, most have been only marginally useful for making instructional design decisions. From a designer's point of view such classification systems either make highly theoretical rather than operational distinctions;[1] or, if operational distinctions are made, they are generally on the basis of the most obvious topographical or procedural dimensions. It may well be, for example, that classifying tasks as cognitive and affective, or learners as ground dependent and independent, or media as audio and visual is an entirely useful scientific activity. Such classifications, however, have proved themselves to be of only limited use to the designers of instruction. In accordance with the position taken by Jackson (above, p. 4) the teacher's need is not primarily for theoretical or even operational categories of learning, teaching, tasks, or machines, but for operational categories of instruction.

Clearly then, the instructional designer's primary need is for a reasonably sophisticated operational category system--one which is based on

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[1] The distinction made here is the one made by Melton (1964, pp. 328-332) who refers to theoretical categories as being those which are inferred on the basis of some abstract property of the phenomenon. Operational categories, on the other hand, are those based on more or less primitive observations of communalities between phenomena, in the absence of detailed knowledge of their content or structure.

the functional nature of the instructional process. Such a category system recognizes inputs, outputs, mediating processes, and interactions. It is within such a category system that instructionally useful criteria and parameters may be identified and ordered. Such a system would not only provide a basis for relating concepts currently evident in the field (e. g., learning experiences, performance objectives, terminal behaviors, proficiency measures), but would also provide a basis for further theoretical investigations. By forcing the designer to look for specific inputs, outputs, and mediating processes, on a number of hierarchical levels, such category systems aid immeasurably in circumventing simplistic, fragmented, and internally inconsistent decision making, and thus should improve the forecasting power of instructional specifications.

3. It seems to me that one of the immediate results of the adoption of such a technological systems rationale would be the improved communication within the instructional enterprise itself.

The fact that the field is currently characterized by a proliferation of unrelated and unrelatable concepts, stipulative and programmatic definitions, and slogans is well recognized (Scheffler 1960). The use of a paradigm with a related functionally based category system should do much to remedy this situation. It should provide: (1) a basis for identifying those instructionally meaningful and significant terms which are currently evident in the literature; and (2) a basis for a theoretical network within which subsequent scientific terminology could be evolved.

The prime examples of the point being made here are the terms "curriculum" and "instruction" themselves. It is generally recognized that there is as yet no agreement as to the referential nature of these phenomena, and that the scientific definition of these terms remains an illusion. In its place, the enterprise has had to be satisfied with the sort of general descriptive statements which identify curricula as: "the total of all the learning experiences of a learner under the direction of the school."

While such definitions may be marginally useful for communication on the layman's level, they are hardly on a par with the sorts of definitions employed by the physicist or chemist for equally abstract phenomena. Such definitions are neither embedded in theoretical structures, nor do they provide any basis for developing subsequent theoretical formulations.

On the other hand, suppose instruction was to be defined using recognized technological systems concepts as: "an idiosyncratic, empirical, and information-processing system in which the curriculum is the monitor"[1], and then a curriculum was subsequently defined as: "an idiosyncratic, symbolic, and information-processing system for the descriptive control of instruction." Such definitions are now not only embedded in an extensive network of systems theory, but provide, in themselves, a basis for developing more specific theoretical

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[1] This definition is a variation of the one suggested by Ericksen (1967, p. 144).

structures, and for inferring theoretically based instrumental strategies and tactics. While the meaning and significance of such definitions may well be questioned, at least, they have been extracted from the social milieu; their vagueness and ambiguity have been restricted; and sets of connections have been established between the two concepts, and between themselves and the real world. Such conditional scientific definitions surely provide a much better basis for communication, theorizing, and instrumentation than do many of the nonscientific definitions currently in use.

4. Technological paradigms such as the one outlined above perform an important identifying and ordering function for the monographer as well as for those concerned directly with the manipulation of empirical sensory data and the generating of theoretical structures. In primitive fields of study, such as instruction, the monographer appears to perform a particularly important function in gathering together the literature of the field and ordering it in a meaningful way.

While many of the monographs[1] in the field of curriculum and instruction have proved useful in organizing the field along a number of dimensions, they have not proved to be particularly valuable sources of design data. Many monographs have made no pretense of providing a handbook function for their readers. Others purport to provide this function, but by the admission of their authors, provide only the most

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[1] A number of such instructional monographs have appeared in the last few years. See especially Ammerman 1966; Beauchamp 1968; Fryklund 1965; Macdonald and Leeper 1965; Mager and Beach 1967; Miller 1963, 1965; Melton 1964; Siegel 1967; Smith 1964, 1966.

simplistic, fragmented, and often subjective view of the task. It seems clear, however, that if design handbooks are ever to perform as crucial role in instructional technology as they do in other technological fields, they must be based on just such integrative and eclectic studies.

Again, the use of a technological design paradigm would help to ensure internal consistency in such studies and handbooks, by drawing the writer's attention to the many hierarchically related input, output, and process relationships which must be accounted for.

5. Finally, the adoption of such a rationale by the instructional enterprise would have important implications for identifying the areas of related professional and institutional responsibility. Instructional design, like other complex design tasks, is clearly an interdisciplinary enterprise. As the engineering and medical enterprises must work in well organized design teams, so must the instructional enterprise.

Clearly, those capabilities required to develop predesign specifications, are not those required for the preparation of design, operational, and/or operations specifications. A careful examination of the substantive content of each such specification provides an important source of inferences as to the membership required in such an interdisciplinary design team. It seems evident, for example, that the predesign stage requires the services of philosophers, economists, and those who have a feel for the general demands and capabilities of a complex society. The design specification, on the other hand, requires the services of subject matter specialists, psycho-and bio-technologists,and human factors engineers. Operational specifications

require the capabilities of communications and media experts, while operations specifications require the capabilities of experienced teachers and administrators and those skilled in operations engineering techniques.

Closely related to the task of identifying the professional responsibilities for instructional design is the task of identifying the institutional responsibilities involved. The fact that the field of instruction has been slow to produce the range of agencies charged with responsibility for invention, development, and implementation, which are characteristic of the fields of engineering and medicine is the case in point. The crucial importance of the parallel development of scientific and technological interdisciplinary teams in the field of instruction has been well documented by a number of writers.[1] Paradigms such as the one outlined here would appear to provide as valuable a basis for institutional organization in instruction, as they do in the fields of engineering and medicine.

In summary, the argument has been that the primary goal and obligation of the instructional enterprise is to identify what ought to be taught and then to set about the task of developing the necessary methods and techniques for doing it. Given this notion of the basic technological nature of instructional goals, it appears that the instructional enterprise should give prerequisite attention to developing related technological modes of functioning. Current literature in the field of engineering technology

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[1] See especially Glaser 1964, Guba 1967, Melton 1960.

suggests that technologist make design decisions in at least four discrete yet mutually supporting and interrelated categories. These categories of functioning have been identified as: predesign, design, operational, and, operations decision making.

I have attempted to demonstrate that these design categories do have meaning and significance in the field of instructional design, and that collectively, they provide a reasonable approach to the problem of providing a useful analytical definition of curricula as comprehensive technological specifications for instruction.

Finally, I have suggested that in addition to the implications of a technological design paradigm for defining such terms as curriculum and instruction, such paradigms also provide the basis for a powerful functionally based category system: for identifying and ordering design parameters and criteria, for organizing the literature of the field which is relevant to the task of instructional design, and for identifying areas of professional and institutional responsibility.

In conclusion, I believe that the most important implication of such a technological rationale and paradigm lies in their potential for pragmatic pay-off. By directing the theorist's attention to the development of technologically oriented conceptual structures, the enterprise is assured of the probability of immediate improvement in the power of its strategies. It is similarly assured of increasingly more powerful strategies through the development of a sound, technologically based, network of theory. The position is not one that sacrifices means for ends, but rather one which focuses instead on the prerequisite nature

of the theoretical means required. The adoption of such a theoretical position appears to put the prerequisite emphasis where it belongs, i. e., on the identifying, ordering, and interpreting of real world contingencies, and on the subsequent development of powerful technological forecasts for their control. It is with data such as these that technologically powerful handbooks are composed. Such handbooks may also include the results of more scientific studies. However, primitive technologies such as instruction are by no means dependent on such scientific data any more than was the success of Roman bridge building.

LIST OF REFERENCES

Ammerman, Harry; et al. The Derivation, Analysis and Classification of Instructional Objecitves. HUMRRO Technical Report 66-4. May 1966. Washington D. C.: Clearinghouse for Federal Scientific and Technical Information, U. S. Dept. of Commerce, 1966.

Cohen, M. R.; and Nagel, E. "Classification and Definition." An Introduction to Logic and the Scientific Method. New York: Harcourt, Brace, 1934. pp.222-245.

Beauchamp, George A. Curriculum Theory. Wilmette, Ill.: Kagg Press, second edition, 1968.

Bloom Benjamin S. ed. Taxonomy of Educational Objectives, Handbook I: Cognative Domain. New York: David McKay Co., 1956.

Callahan, Raymond Eugene. Education and the Cult of Efficiency. Chicago: University of Chicago Press, 1962.

Easton, David. A Framework for Political Analysis. Englewood Cliffs: Prentice Hall, 1965.

Elliott, David L; and Foshay, Arthur W. "Chart and Charter: Recent Developments in Educational Discourse". Review of Educational Research. 1963, 38, 3, 223-244.

Ericksen, Stanford C. "The Zigzag Curve of Learning." Instruction, Some Contemporary View Points. Edited by Lawrence Siegel. San Francisco: Chandler Publishing Co., 1967. pp. 141-180.

Finan, John L. "The System Concept as a Principle of Methodological Decision". Psychological Principles in System Development. Edited by Robert M. Gagné. New York: Holt, Rinehart, and Winston, 1963, pp. 517-546.

Fogel, Lawrence J. Bio-Technology: Concepts and Applications. Englewood Cliffs, N. J.: Prentice Hall, 1963.

Fryklund, Verne C. Analysis Techniques for Instructors. Milwaukee: The Bruce Publishing Co., 1965.

Gagné, Robert M. ed. Psychological Principles in System Development. New York: Holt, Rinehart, and Winston, 1963.

Glaser, Robert. "Implications of Training Research for Education." Theories of Learning and Instruction. The Sixty-third Year book of the National Society for the Study of Education 1964. Chicago: University of Chicago Press 1964, pp. 153-181).

Glaser, Robert., ed. Training Research and Education. New York: Wiley, Science Editions 1965a.

Glaser, Robert., ed. Teaching Machines and Programmed Learning II. Washington: National Education Association, Department of Audio Visual Instruction. 1965b.

Gordon, Ira J. Ed. Criteria for Theories of Instruction. Washington, D. C.: Association for Supervision and Curriculum Development. 1968.

Guba, Egon G. The Basis for Educational Improvement. An address delivered at the Kettering Foundation - U. S. Office of Education National Seminar on Innovation, Honolulu, July 1967.

Hirst, Paul H. "Philosophy and Educational Theory." British Journal of Educational Studies. 1963, 12, 51-64.

Howland, Daniel. " A Regulatory Model for System Design and Operation." Operational Research and the Social Sciences. New York: Travistock Publications 1966, pp. 505-514.

Jackson, Philip W. Life in Classrooms. New York: Holt, Rinehart and Winston, 1968.

Johnson, Mauritz Jr. "Definitions and Models in Curriculum Theory." Educational Theory, 1967, 17, 2, 127-140.

Klohr, Paul R. "Problems in Curriculum Theory Development." Theory Into Practice, 1968, 6, 4, 200-203.

Krick, Edward V. An Introduction to Engineering and Engineering Design. New York:. Wiley, 1966.

Lindvall, C. M. ed. "Defining Educational Objectives." A Report of the Regional Commission On Educational Coordination and the Learning Research and Development Centre. Pittsburgh: University of Pittsburgh Press, 1964.

Maccia, Elizabeth S.; Maccia, George S. and Jewitt, Robert E. Construction of Educational Theory Models. U. S. Department of Health Education and Welfare, Office of Education, Cooperative Research Project, no. 1632. Columbus: Ohio State University, Research Foundation, 1963.

Macdonald, James B.; Leeper, Robert R. eds. Theories of Instruction. Washington: Association for Supervision and Curriculum Development, 1965.

Macdonald, James B. "An Example of Disciplines Curriculum Thinking." Theory Into Practice. 1967, 6, 4, 166-171.

Mager, R. F. Preparing Instructional Objectives. Palo Alto, Cal.: Fearon Publishers, 1962.

Mager, Robert F. and Beach, Kenneth M. Jr. Developing Vocational Instruction. Palo Alto, Cal.: Fearon Publishers, 1967.

McLuchan, Marshall. "We Need aNew Picture of Knowledge". New Insights and the Curriculum. ASCD Yearbook 1963, Edited by Alexander Frazier. Washington: Association for Supervision and Curriculum Development. 1963, PP 57-68.

Meister, David; and Rabideau, Gerald F. Human Factors Evaluation in Systems Development. New York: John Wiley, 1965.

Miller, Robert B. "Task Description and Analysis." Psychological Principles in System Development. Edited by Robert Gagne. New York: Holt, Rinehart, and Winston, 1963, pp. 187-230.

_____. "Analysis and Specification of Behavior for Training." Training Research and Education. Edited by Robert Glaser. New York: Wiley, Science Editions, 1965, pp. 31-62.

Melton, A. W. The Science of Learning and the Technology of Educational Methods. Harvard Education Review, 1965, 29, 96-106.

Melton, A. W. Some comments on "The Impact of Advancing Technology on Methods in Education" by Dr. Simon Rano, Sept. 1959. Teaching Machines and Programmed Learning I. Edited by A. A. Lumsdaine and Robert Glaser. Washington: Dept. of Audio-Visual Instruction, National Education Association, 1960, pp. 660-664.

Melton, Arthur W., ed. Categories of Human Learning. New York: Academic Press, 1964.

Polanyi, Michael. Personal Knowledge. Chicago: University of Chicago Press, 1958.

Scheffler, Israel. The Language of Education. Springfield, Ill.: C. C. Thomas, 1960.

Siegel, Lawrence, ed. Instruction, Some Contemporary View Points. San Francisco: Chandler Publishing Co., 1967.

Smith, Robert G. Jr. The Development of Training Objective. Technical Report P. B. 167-689. Alexandria Virginia: The George Washington University, Human Resources Research Office, 1964.

_____. The Design of Instructional Systems - Technical Report 66-68. Alexandria Virginia: The George Washington University, Human Resources Research Office, 1966.

Travers, Robert M. W. "Towards Taking the Fund out of Building a Theory of Instruction." Rational Planning in Curriculum and Instruction. Washington: National Education Association, Centre for the Study of Instruction, 1967, pp. 33-53.

_____. Some Further Reflections on the Nature of a Theory of Instruction. Toronto: The Ontario Institute for Studies in Education, 1967. Unpublished paper.

Tyler, Ralph W. Basic Principles of Curriculum Development. Chicago: University of Chicago Press. 1950.

Wigglesworth, V. B. "The Contribution of Pure Science to Applied Biology." The Annals of Applied Biology. 1955, 42, 34-44.

Wolman, Benjamin B. "Towards a Science of Psychological Science." Scientific Psychology. Edited by Benjamin B. Wolman and Ernest Nagel. New York: Basic Books, 1965, pp. 3 - 23.